MIDAS

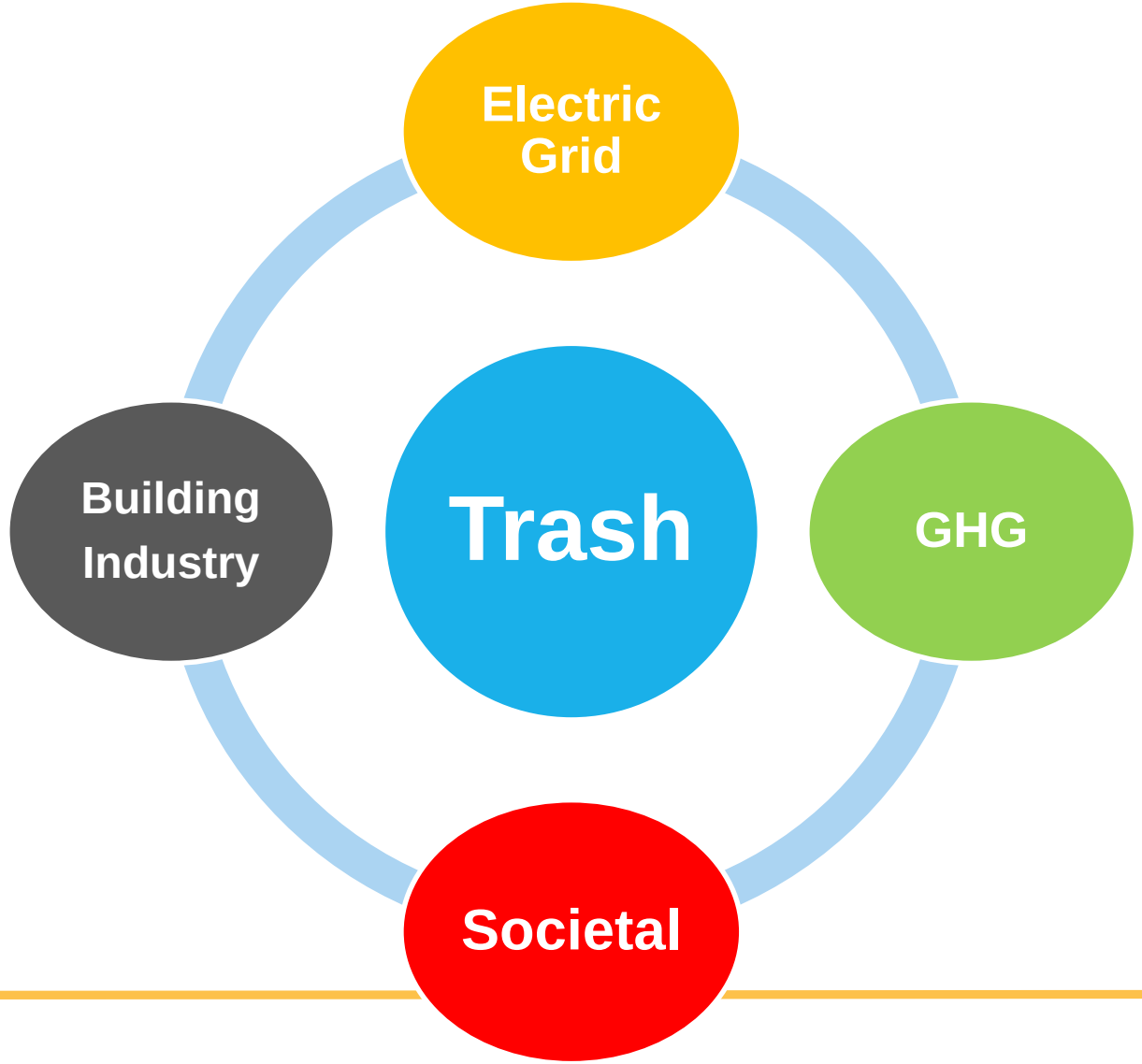
Monetizing Innovative Disposal Applications and Solutions

Webinar for November 7/8 Workshop

Douglas Wicks
Program Director
ARPA-E, Department of Energy

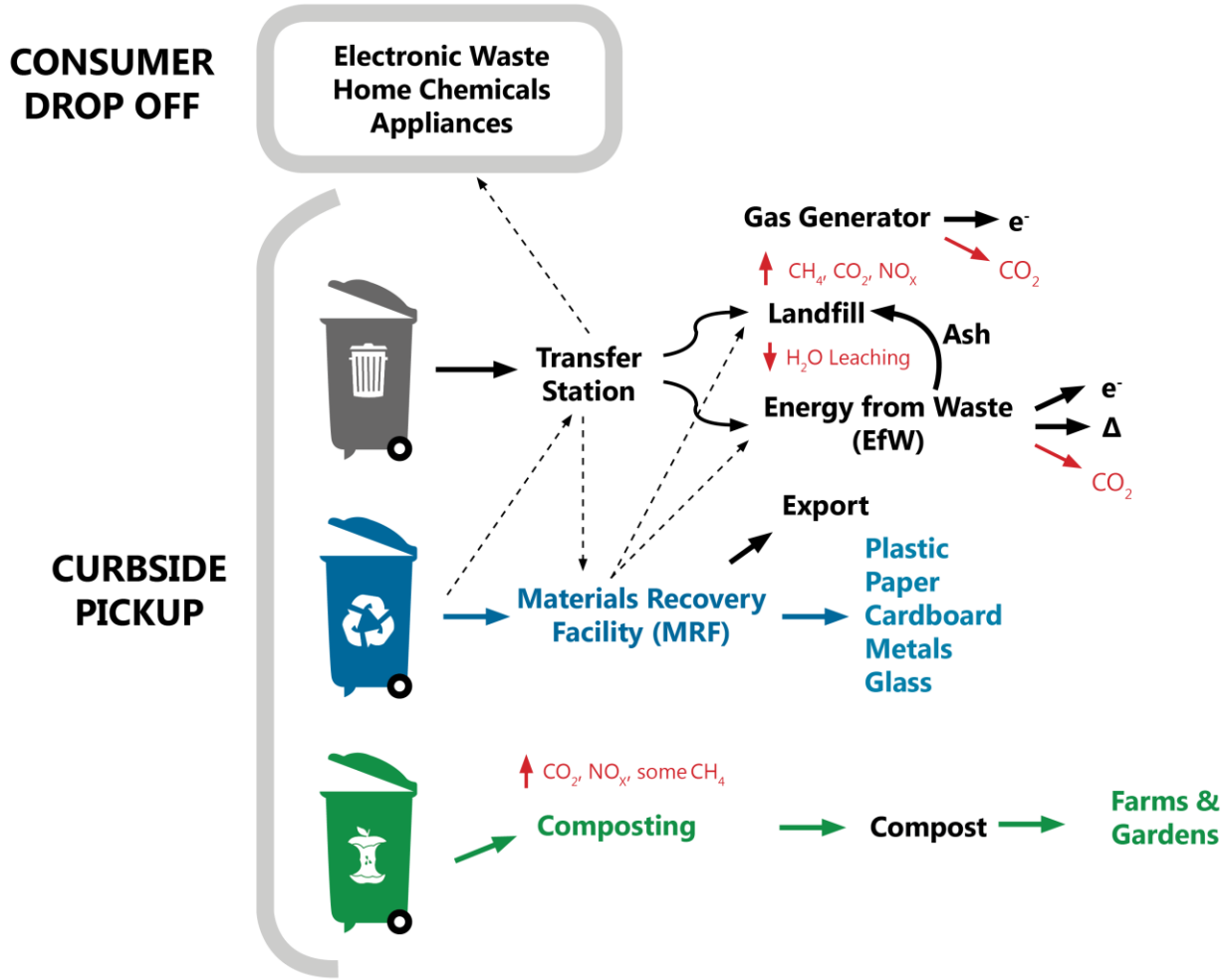
Let's talk trash.

MSW is Surrounded by Seismic Changes



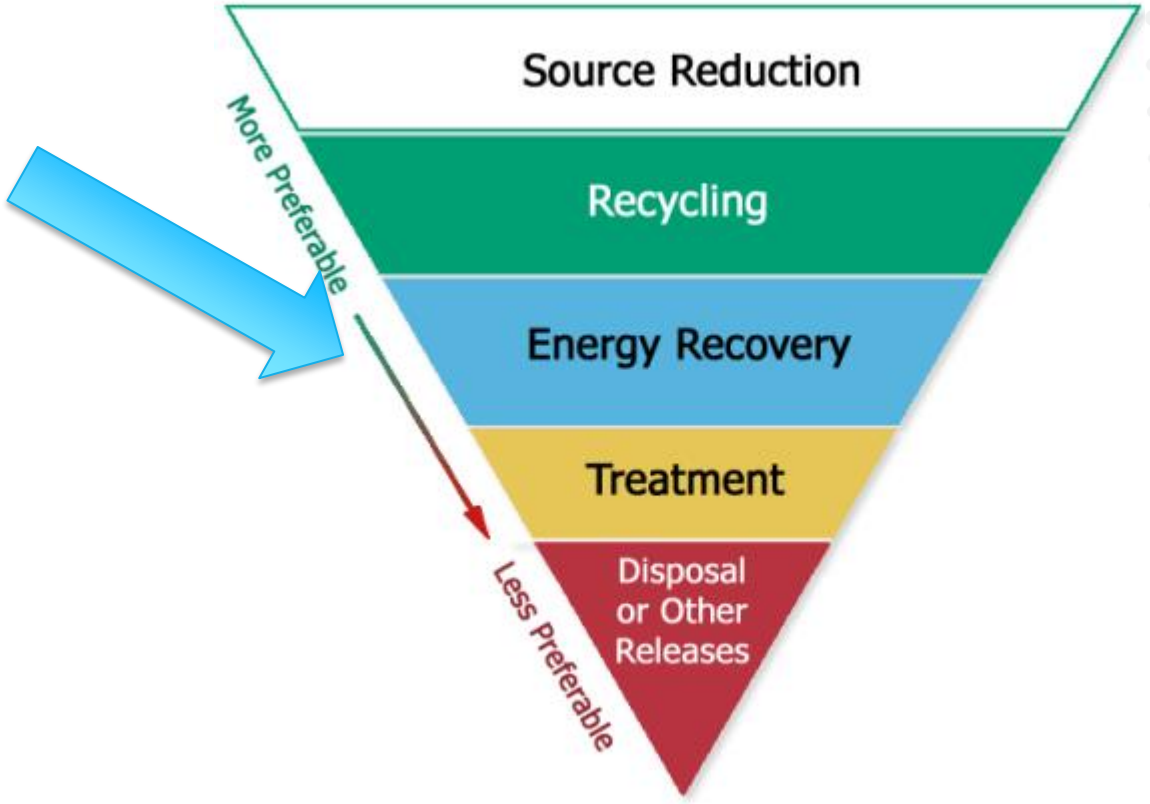
Take Some Time to Ponder – Where does it go?

- Curbside Trash Pickup
  - Contains literally everything (and maybe a kitchen sink)
  - Large amount of recyclables
- Curbside “Recycling”
  - Poor customer compliance
- All waste takes a long road trip to its final destination.



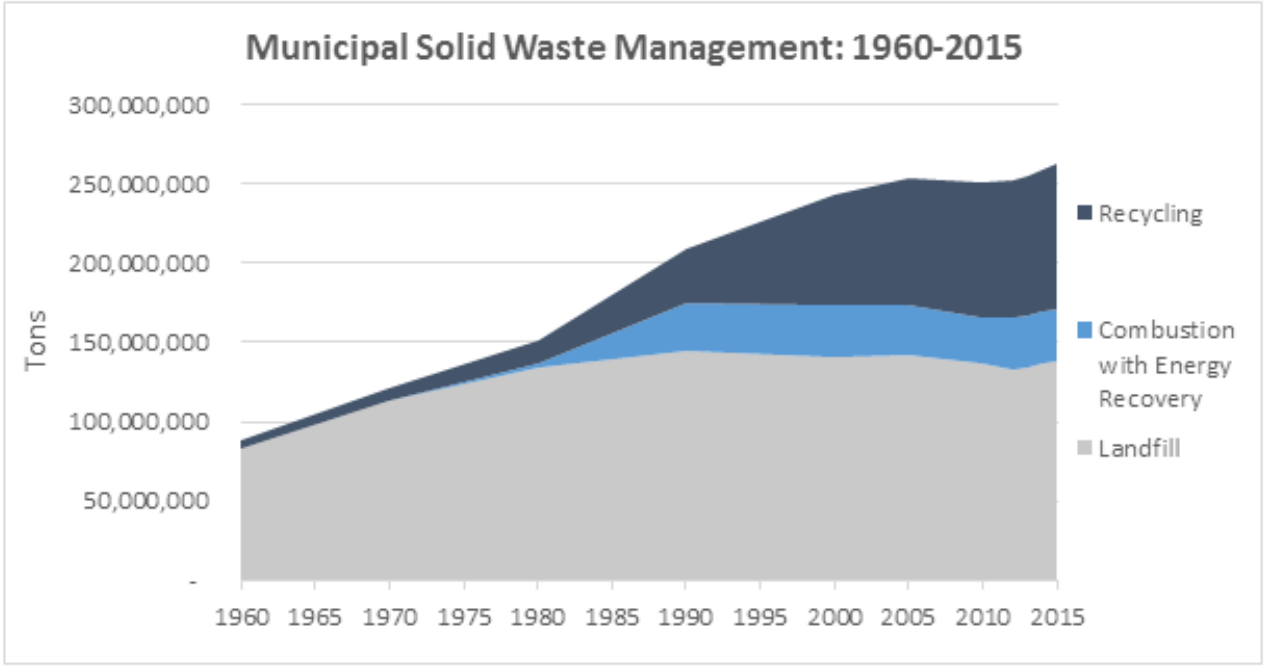
Please NOTE!

- Recovery of energy from waste IS part of the EPA's hierarchy of waste handling.
- The intent of this program is to increase resource recovery while enhancing recycling and eliminating disposal.
- Metrics for the program will address
  - Energy
  - Environment
  - Economics



Disposition of MSW in US

- Landfilling is the primary method
  - Volumes “flat”
  - Cost increasing rapidly
- “Recycling” has increased
  - About 1/4th composted
  - About 1/3rd of remainder was exported
- WTE – Flat for 30 years

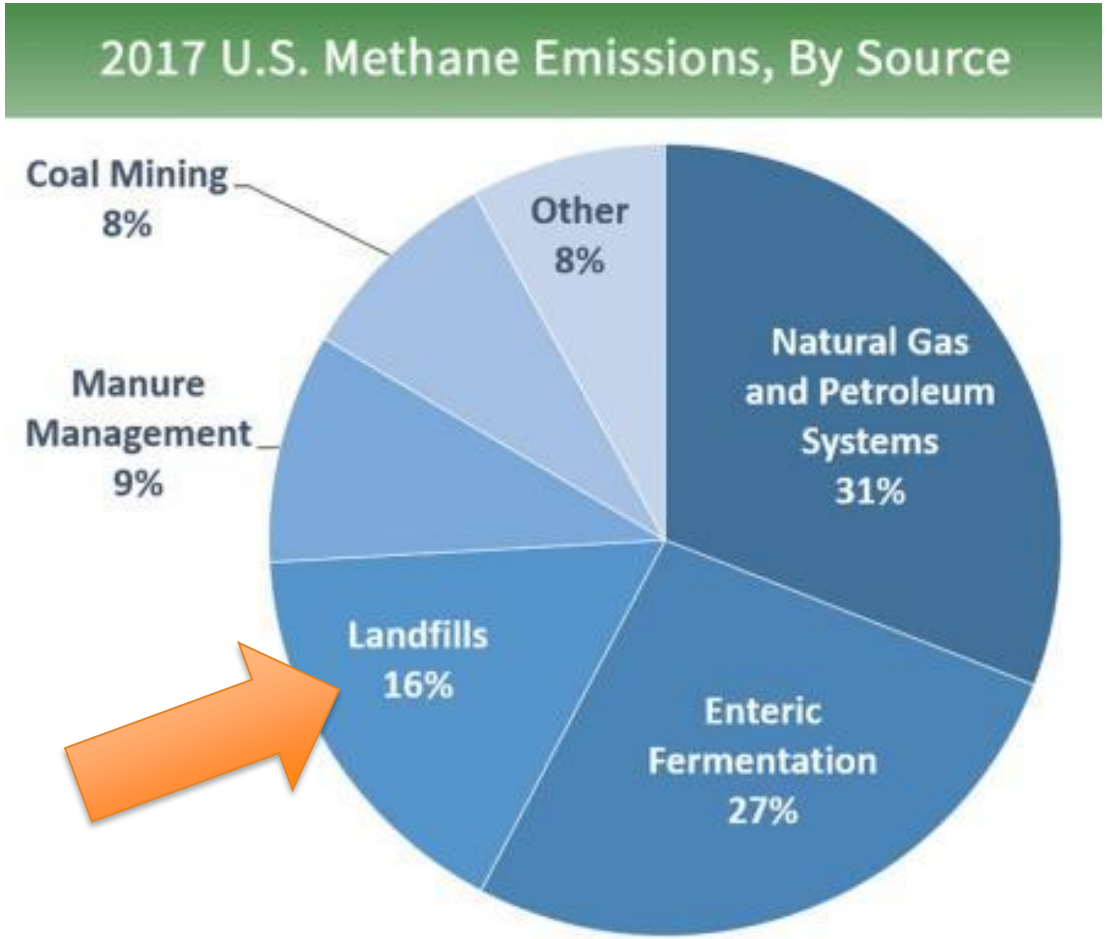


Please note that there are wide ranging estimates of MSW in US
EPA numbers represent reported MSW collection

https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials

Issues with Landfilling

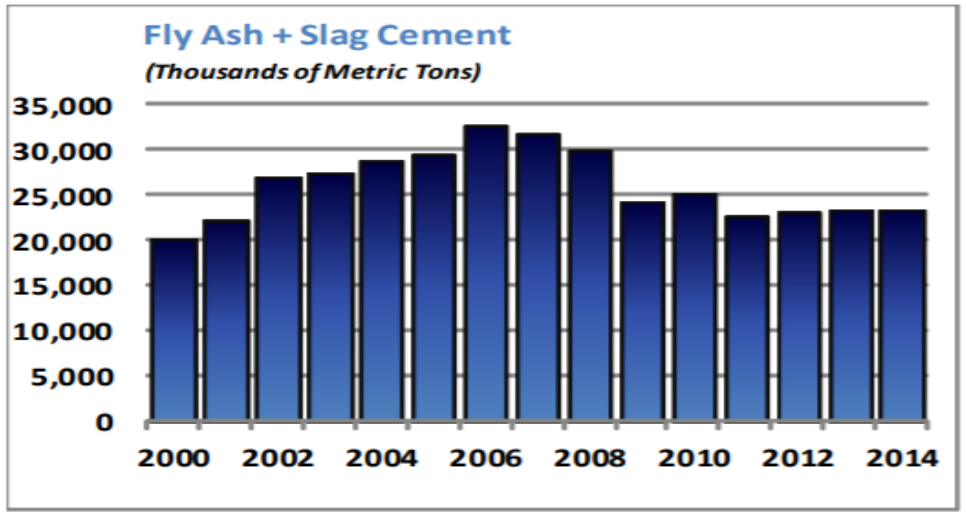
- Wasted Embodied Energy
  - US > 2 quadrillion Btu's of thermal energy
- GHG Emissions
  - 3rd largest source of methane even with abatement
  - Biogenic CO2
  - NOx
- Other
  - 30 million tons of metals
  - 50 million tons of inorganics
  - Water runoff
  - Active biology community

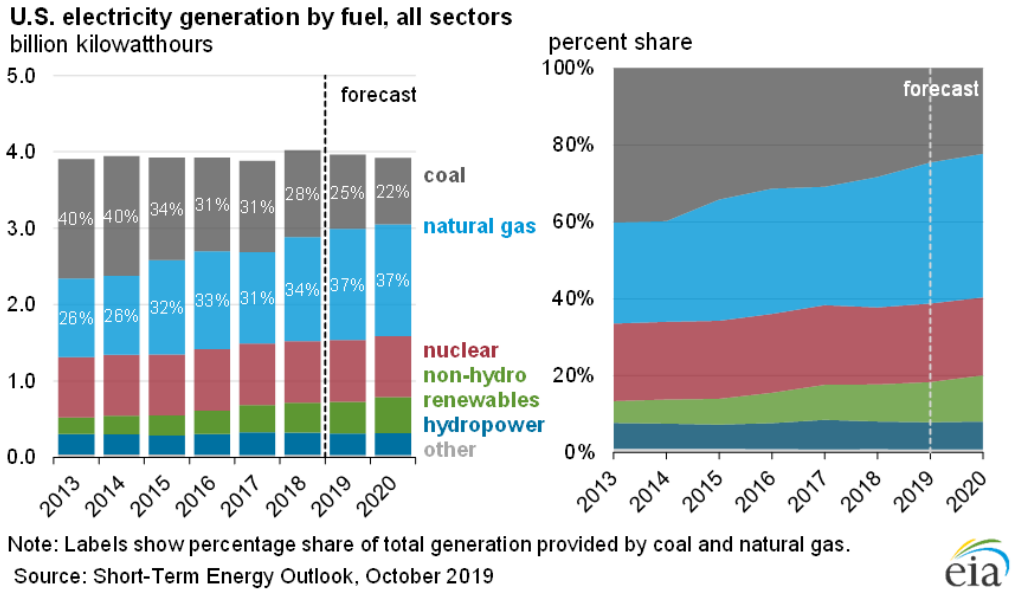


Changes to the Construction Area

Supplementary Cementitious Material (SCM)

- Coal fly ash and steel slag are critical to high performance construction materials
- Both of these wastes are in decline





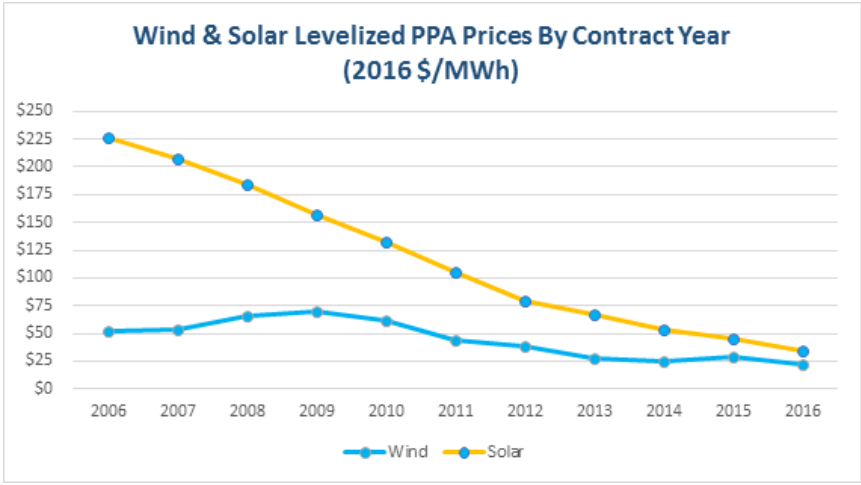
Note: Labels show percentage share of total generation provided by coal and natural gas.
Source: Short-Term Energy Outlook, October 2019

2016 U.S. Cement Industry Annual Yearbook
http://www2.cement.org/econ/pdf/Yearbook2016_2sided.pdf

CHANGING WHAT'S POSSIBLE

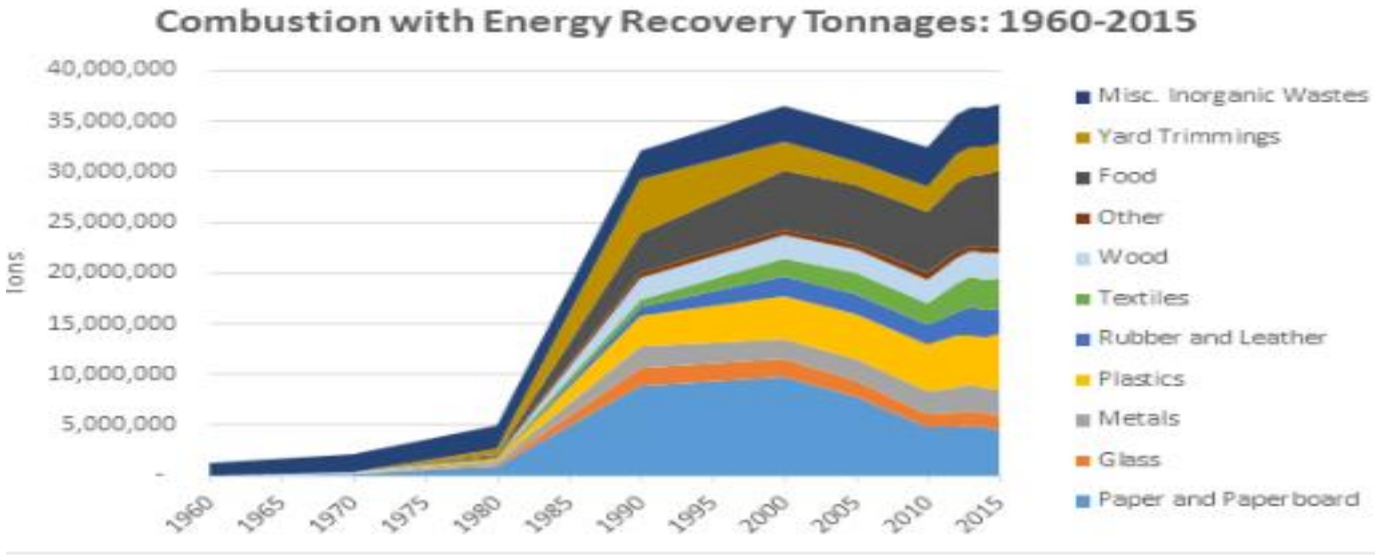
Challenges Facing W2E Operations

- Dropping Electricity Value
  - Deregulated electricity markets
  - Rapid penetration of renewables disrupting baseload needs
- Combustion Residue Disposal
  - Landfill tipping fees
  - Logistics
  - Liability
- Community Perception



MSW -> Energy in the US

- Currently 71 plants*
- Generating 15 billion kwh
  - Equivalent to 120 trillion btu's of natural gas generation **
  - Some a dedicated to steam production
- Reductions resulting from combustion
  - 90% in volume
  - 70% in mass



https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials

arpa·e CHANGING WHAT'S POSSIBLE

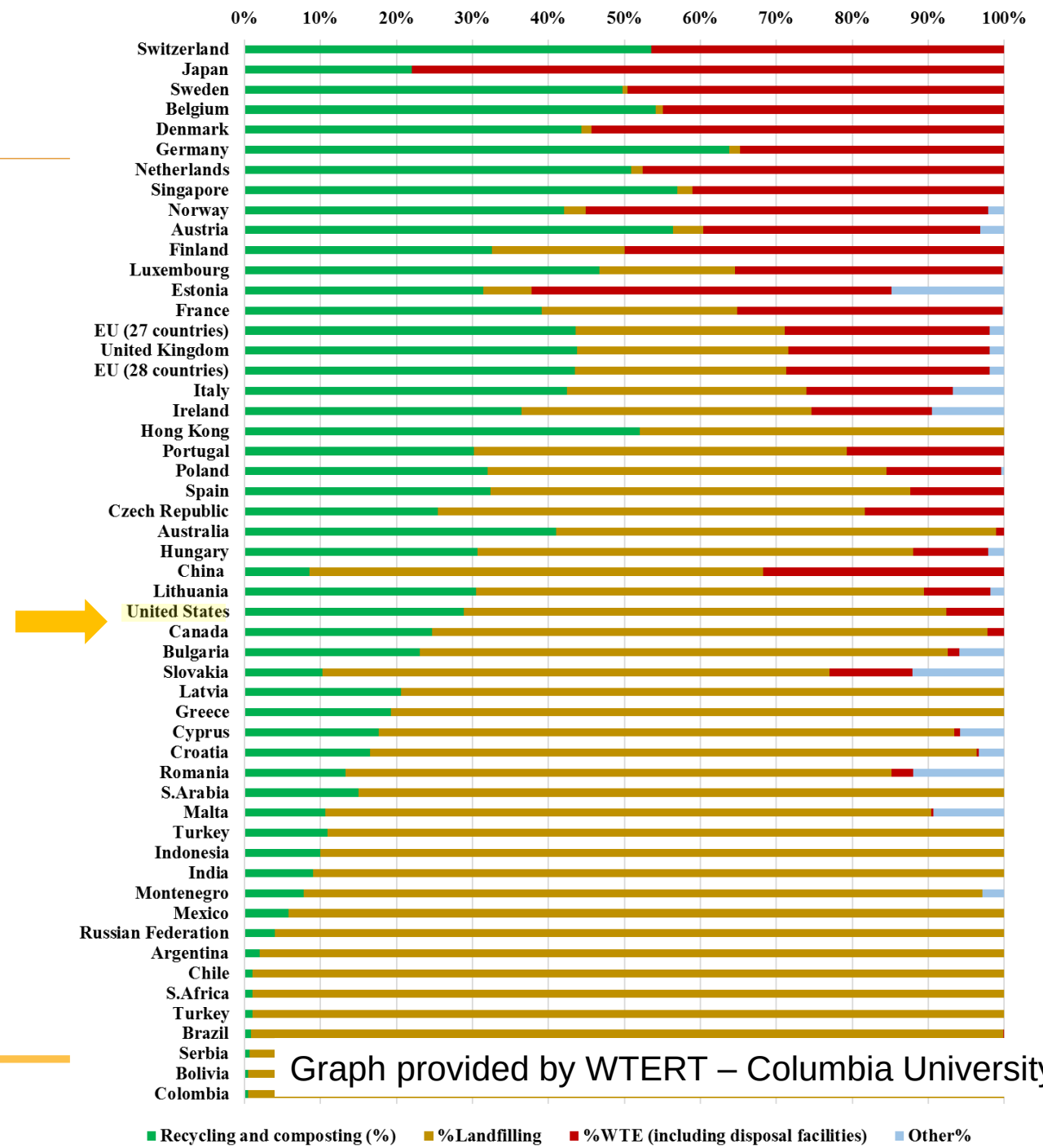
* 71 – EIA, 79 – EPA, 75- Energy Recovery Council

** https://www.eia.gov/electricity/annual/html/epa_08_01.html

Global Benchmarks

The US is

- Behind on addressing MSW
- 2nd total MSW Generation
- 22nd per capita MSW*
  (but math is not our strength)
- Lagging in landfill avoidance



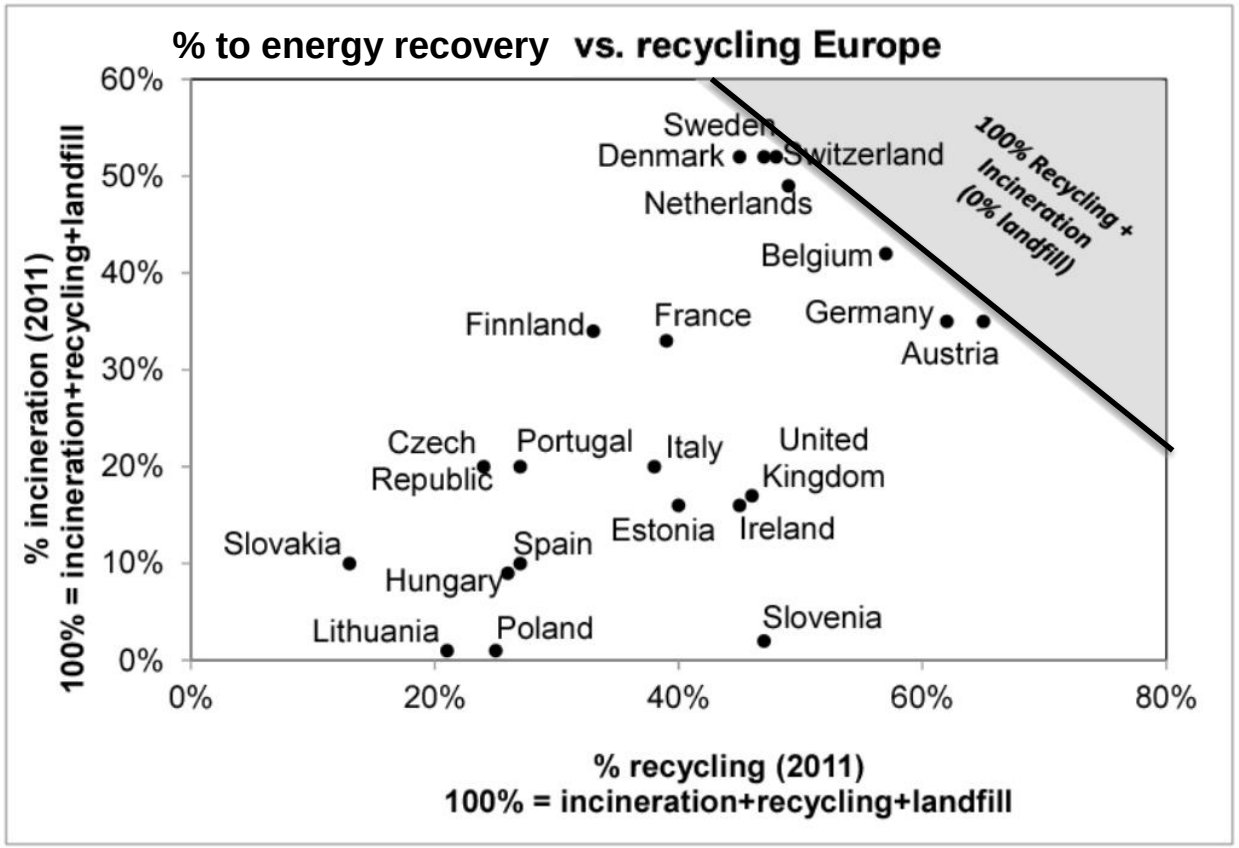
Graph provided by WTERT – Columbia University

http://siteresources.worldbank.org/INTURBANDEVELOPMENT/Resources/336387-1334852610766/AnnexJ.pdf

arpa·e
CHANGING WHAT'S POSSIBLE

Lessons from the Leaders

- Waste to energy does not preclude effective recycling and composting
- Effective recycling does not alleviate the need for additional disposal methods



Bunge – Metals_from_MWIBA.pdf

Garbage In, _____ Out

1 Ton

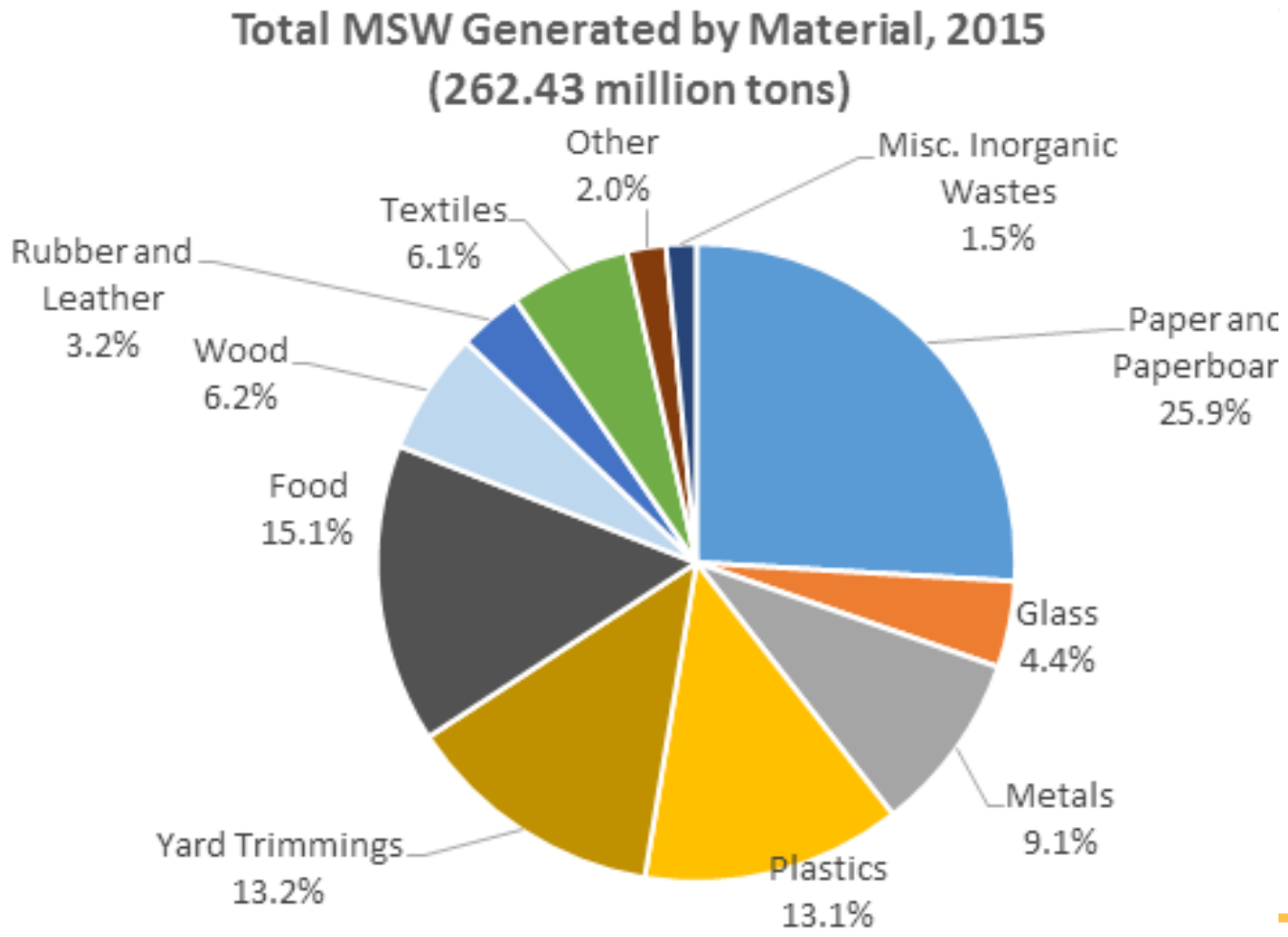
Energy

Best in Class
500 KWh Electricity
+
1000 KWh Heat

Combustion Residue
1/5th -1/3rd Ton

What Contributes to Combustion Residue?

- Wood and food waste
  - Silica, K, Ca, Mg, Na, P, Cl
- Fillers in paper and board
  - $CaCO_3$, Aluminosilicates
- Plastics, paint
  - $CaCO_3$, Silicates, TiO_2, Zn
- Glass
  - Silica from fibers
- Kitty litter
  - Aluminosilicates, silicates, and…
- PVC
  - Chlorides, $CaCO_3$
- Bricks, tiles, construction debris, rocks…
- Cylinders, pipes, fixtures…
- Electronics…



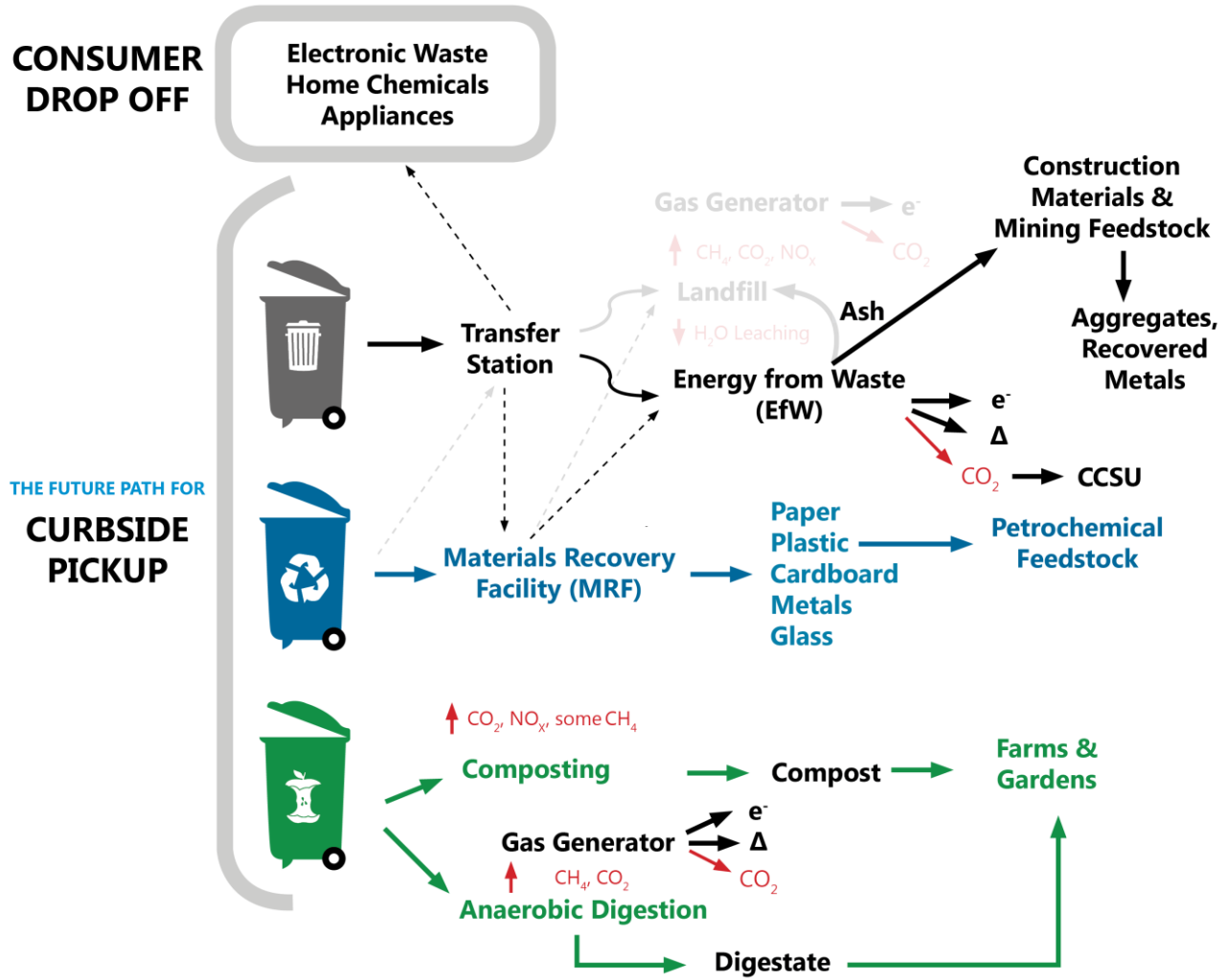
https://www.epa.gov/sites/production/files/2018-07/image2_0.png

MSW and ARPA-E's Mission

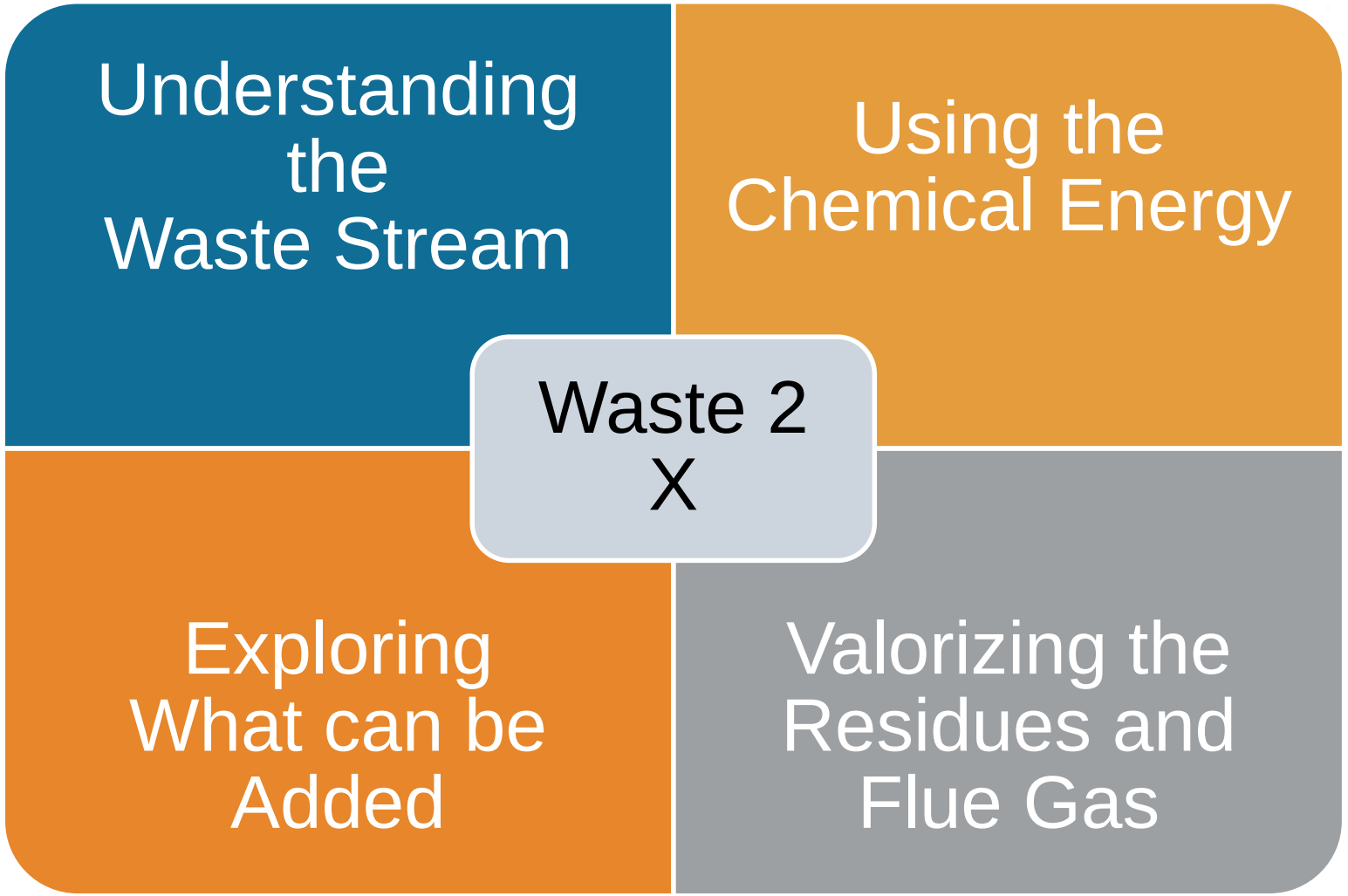
Mission: Development of applications and solutions that …

Outcomes to Explore

- Can we eliminate need for landfill?
- What is the optimum mix to pursue?
  - Recycle
  - Reuse
  - Energy Recovery
- What is the optimum use of the embodied energy?



MSW Conversions – What is ARPA-E Hard?

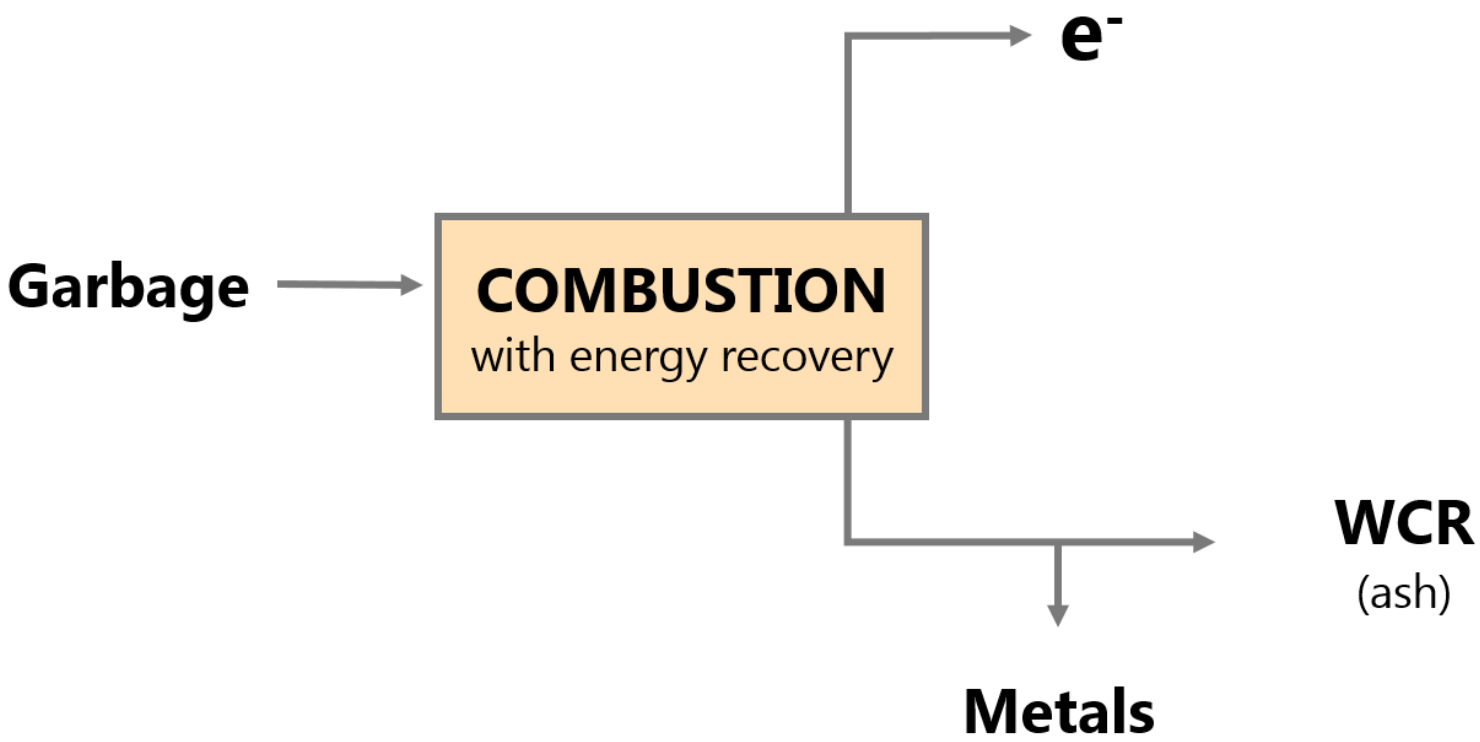


MSW Conversions – Two time horizons

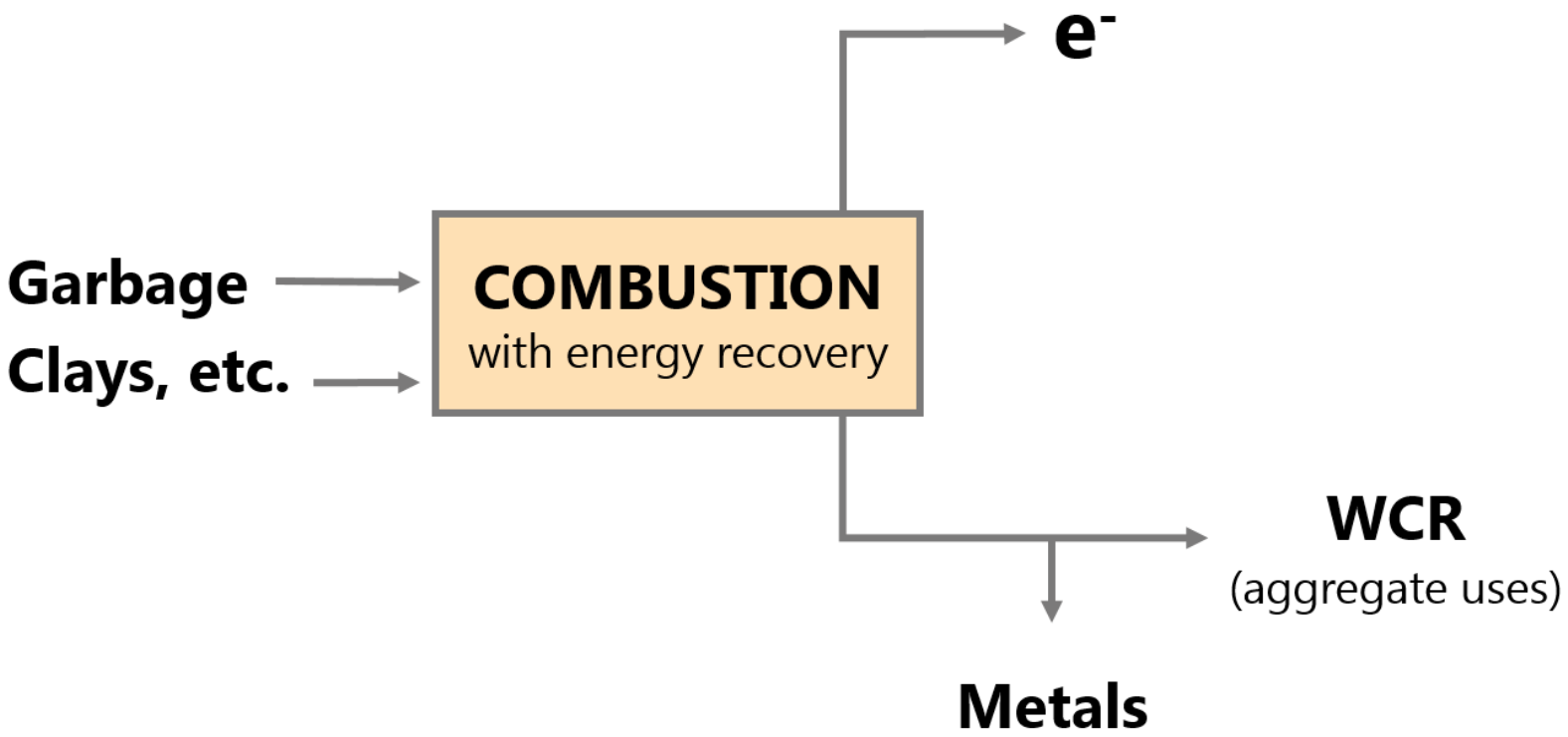
- Existing Assets
  - Average 30 years old
  - Extensive refits
  - Designed for a different business and regulatory environment

- Next Generation
  - Combination of approaches based on local needs
  - Designed for full conversion

MODEL 1: WTE (combustion with energy recovery)

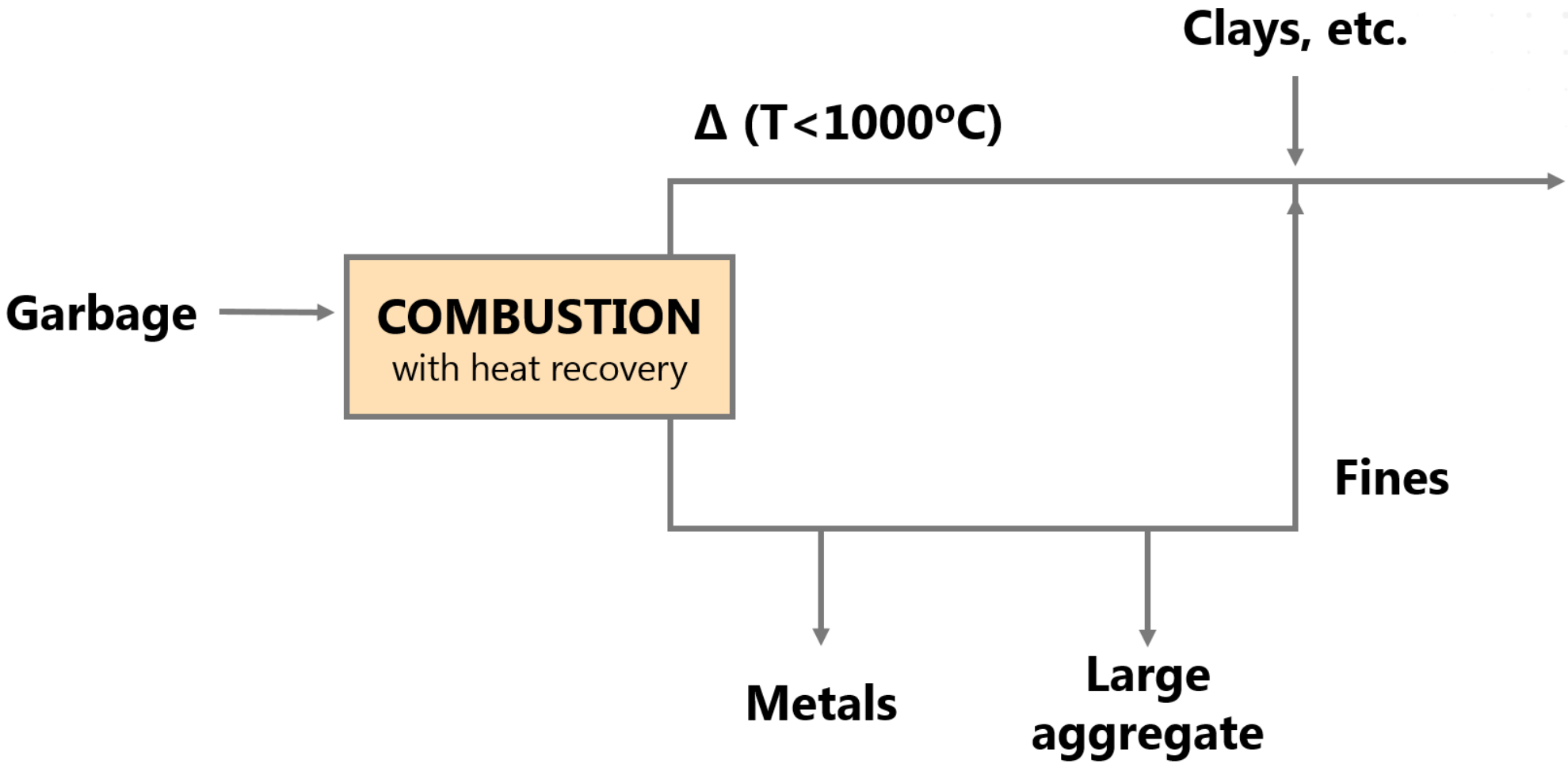


MODEL 2: WTE with up-front additives

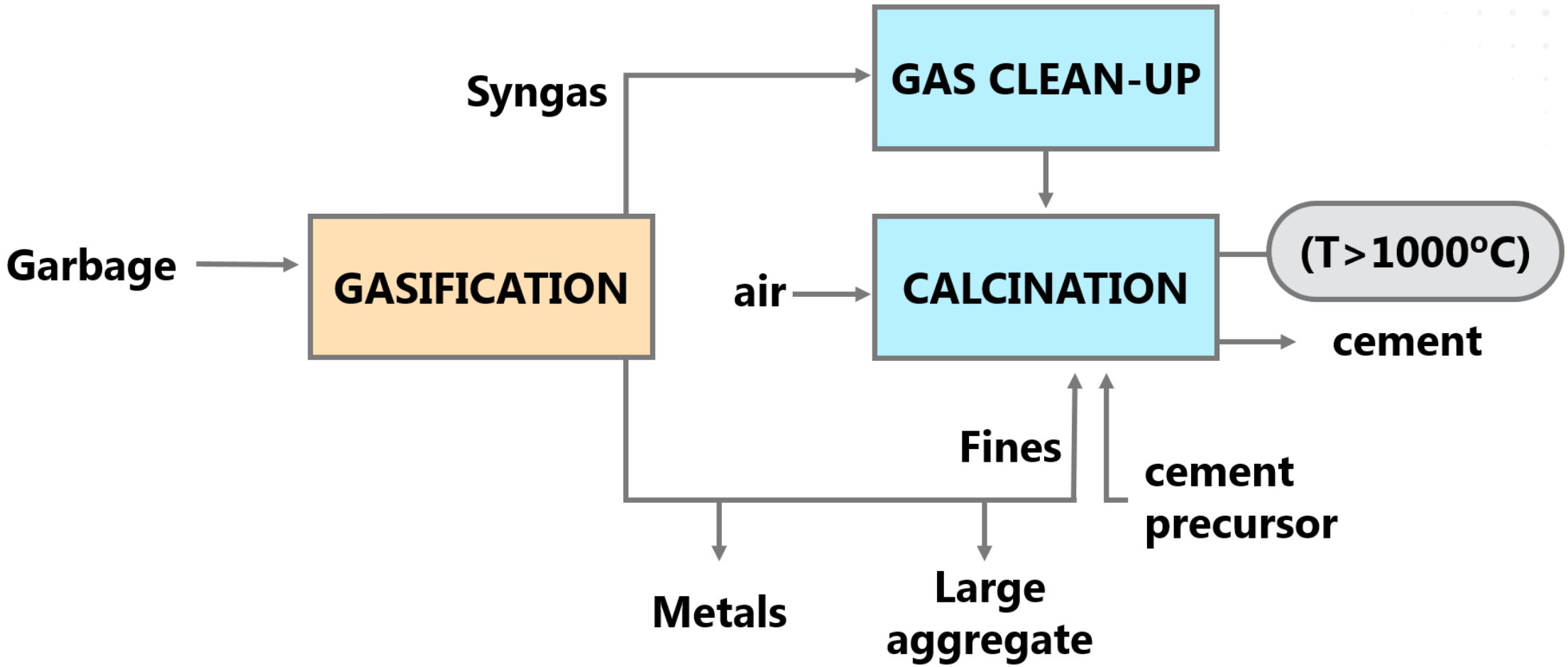


MODEL 3: Combustion Heat Utilization

(no power generation)



MODEL 4: Gasification for Cement Production

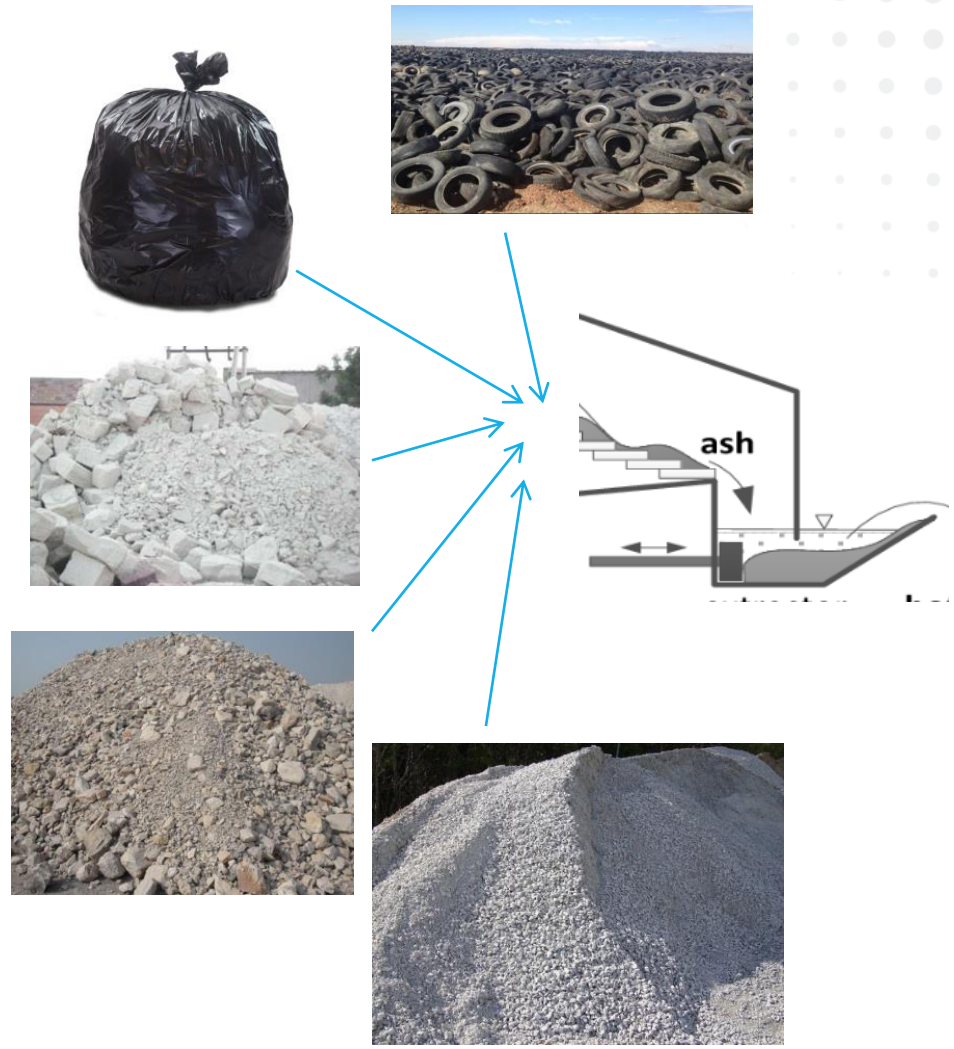


Understanding the Waste Stream

- What are methods to Characterize, Classify, Partition?
  - AI and machine recognition
  - Connecting back to pick up schedules
  - Selective removal before energy recovery
    - Recyclables, unwanted contaminants
  - Monetizing the data
- Recycle vs Combustion vs Gasification vs ?
- What wastes beyond municipal should be discussed?

Exploring What can be Added

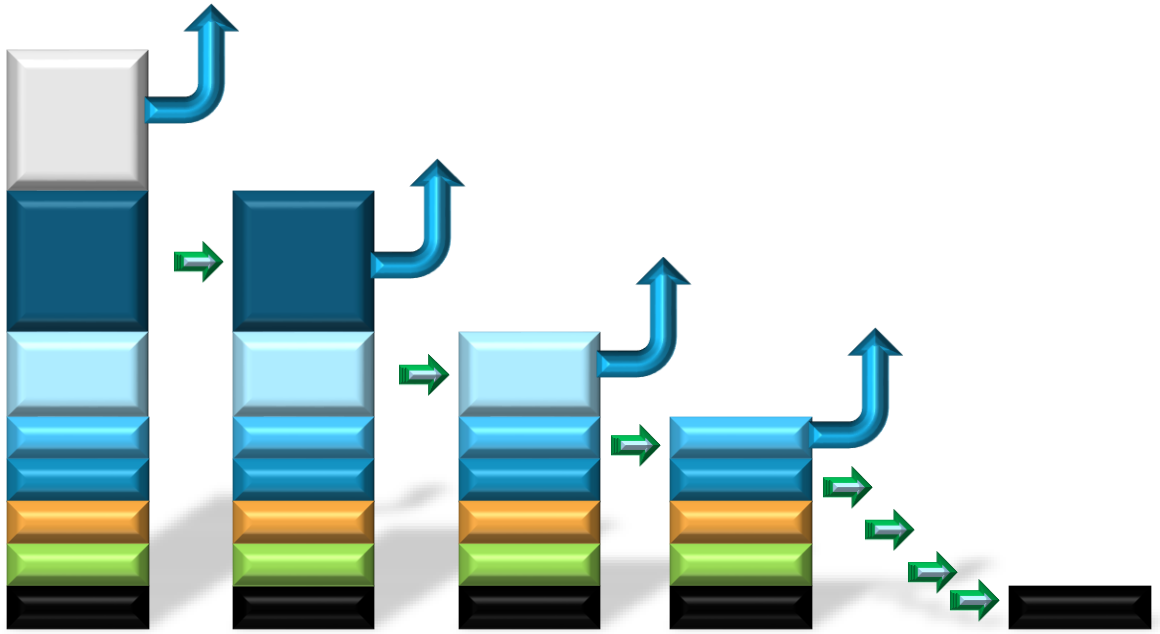
- What additional materials can be fed to the combustion/gasification process?
  - Benefits to combustion residue? Aggregates?
  - Impact on energy recovery?
  - Methods for dynamically changing feed rate(s)?
- Are there upfront additives that would benefit combustion and emissions?
  - Reduced slagging, NOx, halogens
- What about shifting to gasification?



Valorizing the Residue

- What are the best practices in the industry for combustion residue reuse?
- What rapid, in line analytical tools can be used to characterize combustion residues?
- What can we learn from coal combustion residues?
- Can we cleanly separate critical materials out for recycle?

Ash "Distillation"



Throughout the Meeting

- Listen, participate
- Ask the complex and simple questions
- Think about the big picture and interactions
- Network and meet new people

  Solutions will require teams